Study of Fruit Waste Reuse as New Thermal Absorbing Materials

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Food and agro-industrial waste can be an advantageous resource for energetic utilization through thermal energy processes [1]. Every year, over 220 million tons of food waste is produced in Europe [2], making the implementation of methods for its reuse an environmentally friendly and economically viable solution. Materials that have the ability to concentrate heat in their system, releasing it afterwards to the environment or absorbing heat from its surroundings can be used in several heat-transfer applications, contributing to reduction of the energy consumption in home heating systems, air conditioning and industrial processes. Among the food and agro industrial waste produced, cereals and fruits generate high amounts of waste materials such as peels, hard shells, seeds and stones. Although most of the recent literature focuses on the use of these natural materials as adsorbents (activated or carbonized forms) [3-8] or as a resource for biofuels [9], it is known that fruit seeds and cereals can be used as heat transfer fillers in pads for pain relief [10], typically presenting high heat storage. The solids are already successfully used as biomass fuels, and theoretically can replace glass or other zeolite materials used in boiling/condensation industrial/pilot plants. The liquid/emulsions that have a high heat capacity and thermal conductivity can be applied as biodegradable heat-transfer fluids, in replacement of actual petroleum derived oils used in industry and domestic heating. For such applications it is crucial to know with accuracy the thermophysical properties since monitoring is fundamental [11, 12]. The accurate knowledge of the heat capacity of such systems becomes then a valuable tool.

The interest and usefulness of the exploratory work has risen from the lack of knowledge that exists for the thermal properties of these materials. The objective of this work was to determine the heat capacity, thermal diffusivity and thermal conductivity of these materials, being that this last property was studied for the powdered samples and for their suspensions in an ionic liquid (nanofluids), here designated as IoBiofluids, and in water with a surfactant. From the experimental measurement of thermal diffusivity and heat capacity it was found that the thermal conductivity of walnut shell powder is greater than the thermal conductivity of the cherry stone powder which in turn is higher than that of the hazelnut shell powder. In this experimental study it was possible to ascertain a bigger similarity between the nut shell and the cherry stone, pertaining to both their structures and their thermal properties (thermal conductivity and heat capacity). The thermal conductivity and the heat capacity of the nut shell have higher values when compared to the other samples analyzed. The thermal conductivity versus temperature study of suspensions containing 2% (w/w) of powdered samples in water and surfactant has shown that the addition of several powders to this medium can heighten this property, making the application of fruit residues to heat transfer fluids a viable option [13]. Considering this results, we can now proceed with the study of suspensions using these materials (fruit residue powders) in ionic liquids (IoBiofluids) as an alternative to the existing heat transfer fluids and even to IoNanofluids. This work focuses exclusively on the non-edible portions of the fruit to avoid the "food/fuel dilemma" [14].

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